



Office de la Propriété
Intellectuelle
du Canada

Un organisme
d'Industrie Canada

Canadian
Intellectual Property
Office

An agency of
Industry Canada

CA 2500371 A1 2004/04/08

(21) **2 500 371**

(12) **DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION**

(13) **A1**

(86) Date de dépôt PCT/PCT Filing Date: 2003/09/16
(87) Date publication PCT/PCT Publication Date: 2004/04/08
(85) Entrée phase nationale/National Entry: 2005/03/24
(86) N° demande PCT/PCT Application No.: SE 2003/001440
(87) N° publication PCT/PCT Publication No.: 2004/028256
(30) Priorité/Priority: 2002/09/24 (0202810-8) SE

(51) Cl.Int.⁷/Int.Cl.⁷ A01N 65/00, A01N 31/08, A01N 31/04

(71) Demandeur/Applicant:
FORSKARPATENT I SYD AB, SE

(72) Inventeurs/Inventors:
BENGTTSSON, MARIE, SE;
JAASTAD, GUNNHILD, NO;
KOBRO, SVERRE, NO;
LOEFQVIST, JAN, SE;
WITZGALL, PETER, SE

(74) Agent: MCCARTHY TETRAULT LLP

(54) Titre : ATTRACTIF POUR FAUSSE TEIGNE DE LA POMME ET AUTRES PARASITES DE LA POMME

(54) Title: ATTRACTANT FOR APPLE FRUIT MOTH AND OTHER INSECT PESTS OF APPLE

(57) Abrégé/Abstract:

The present invention relates to the use of behaviour modifying volatile plant compounds of rowan *Sorbus aucuparia* and apple *Malus domestica* for a determination of a population or controlling pest insects on apple, in particular apple fruit moth *Argyresthia conjugella* Zeller (Lepidoptera, Argyresthiidae) and codling moth *Cydia Pomonella* L. (Lepidoptera, Tortricidae). The compound 2-phenylethanol, only or in combination with other compounds, in particular anetole, efficiently attracting females and males of apple fruit moth *A. conjugella*. Other compounds identified from rowan and apple include p-anisaldehyde, (E)-beta-farnesene, farnesol, (Z)3-hexenyl 2-methylbutanoate, linalool and methylsalicylate efficiently attracting apple fruit moth, codling moth and other important pest insects of apple.



(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
8 April 2004 (08.04.2004)

PCT

(10) International Publication Number
WO 2004/028256 A1

(51) International Patent Classification⁷: **A01N 65/00**,
31/08, 31/04

(74) Agent: **STRÖM & GULLIKSSON IP AB**; Sjöporten 4,
S-417 64 Göteborg (SE).

(21) International Application Number:
PCT/SE2003/001440

(22) International Filing Date:
16 September 2003 (16.09.2003)

(25) Filing Language: Swedish

(26) Publication Language: English

(30) Priority Data:
0202810-8 24 September 2002 (24.09.2002) SE

(71) Applicant (*for all designated States except US*):
FORSKARPATENT I SYD AB [SE/SE]; Teknopol,
S-223 70 Lund (SE).

(72) Inventors; and

(75) Inventors/Applicants (*for US only*): **BENGTSSON**,
Marie [SE/SE]; Iliongränden O:228, S-224 71 Lund
(SE). **JAASTAD**, Gunnhild [NO/NO]; N-5777 Grimo
(NO). **KOBRO**, Sverre [NO/NO]; Lillerudvn 66, N-1454
Fagerstrand (NO). **LÖFQVIST**, Jan [SE/SE]; Vallby 16,
S-245 92 Staffanstorps (SE). **WITZGALL**, Peter [SE/SE];
Iliongränden O:228, S-224 71 Lund (SE).

(81) Designated States (*national*): AE, AG, AL, AM, AT (util-
ity model), AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA,
CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (util-
ity model), DE, DK (utility model), DK, DM, DZ, EC, EE
(utility model), EE, EG, ES, FI (utility model), FI, GB, GD,
GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR,
KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN,
MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU,
SC, SD, SE, SG, SK (utility model), SK, SL, SY, TJ, TM,
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM,
ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM,
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),
Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,
ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO,
SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM,
GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

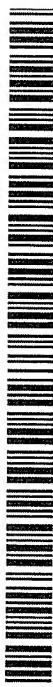
Published:

— with international search report

*For two-letter codes and other abbreviations, refer to the "Guid-
ance Notes on Codes and Abbreviations" appearing at the begin-
ning of each regular issue of the PCT Gazette.*

(54) Title: **ATTRACTANT FOR APPLE FRUIT MOTH AND OTHER INSECT PESTS OF APPLE**

(57) Abstract: The present invention relates to the use of behaviour modifying volatile plant compounds of rowan *Sorbus aucuparia* and apple *Malus domestica* for a determination of a population or controlling pest insects on apple, in particular apple fruit moth *Argyresthia conjugella* Zeller (Lepidoptera, Argyresthiidae) and codling moth *Cydia Pomonella* L. (Lepidoptera, Tortricidae). The compound 2-phenylethanol, only or in combination with other compounds, in particular anetole, efficiently attracting females and males of apple fruit moth *A. conjugella*. Other compounds identified from rowan and apple include p-anisaldehyde, (E)-beta-farnesene, farnesol, (Z)-3-hexenyl 2-methylbutanoate, linalool and methylsalicylate efficiently attracting apple fruit moth, codling moth and other important pest insects of apple.



WO 2004/028256 A1

TITLE**ATTRACTANT FOR APPLE FRUIT MOTH AND OTHER INSECT PESTS OF APPLE****DESCRIPTION**

5 Technical Field

The objective of the present invention is to obtain an efficient method for controlling apple fruit moth *Argyresthia conjugella* Zeller (Lepidoptera, *Argyresthiidae*), codling moth *Cydia pomonella* L. (Lepidoptera, *Tortricidae*), and other important insect pests of apple, such as the green budworm moth *Hedya nubiferana* Haw. and *Pandemis*
10 *heparana* D. & S. (Lepidoptera, *Tortricidae*).

Males and females of many insect species are attracted to their respective host plants prior to mating, which function as sexual rendez-vous sites. This attraction is mediated largely by olfactory cues, i.e. volatile compounds or odours emanating from
15 plants, while visual cues usually play a minor role. After mating, the gravid females use host plant odours to identify suitable sites for egg-laying.

Plant volatile compounds function as bisexual attractants, for both males and females. These compounds can be used to monitor the presence and population density of insect
20 species and to thus determine whether control measures are necessary, and to optimize the time of control measures. For moths, sex pheromones are widely used for monitoring, but sex pheromones attract only males. Attraction of females adds important information, especially as this allows to determine whether the females have already been mated or not.

25

Plant volatile compounds can also be used to control infestations, by mass trapping of insects in a trap-like enclosure or platform, or in combination with an insecticide as a lure and kill formulation, or by disrupting the host-finding behaviour of the adult
30 moths.

35

The investigation of compounds responsible for attraction of insects to their host plant usually relies on the identification of compounds released by the respective host plant. For insects feeding on apple, compounds from apple would accordingly be the prime target for behavioural studies. The use of apple compounds for insect control in
apple orchards is, however, associated with a most important practical difficulty:
apple trees release large amounts of volatiles and sources of artificial apple odour
may be outcompeted by the background of natural apple odour.

Insects have frequently adapted to new host plants during phylogenetic development and host-shifts are considered to play an important role in the speciation process. Many insects feeding on apple *Malus domestica* (Rosaceae) are thus phylogenetically related to species feeding on other plants from the Rosacean family, and are
5 accordingly equipped with the sensory apparatus, i.e. antennal receptors, for plant compounds which are not typical for apple, but for Rosacean plants other than apple. Other insect species feed on several Rosacean plants, including apple, and may switch between hosts according to availability.

10 Certain compounds from Rosacean plants other than apple may therefore have a behavioural effect on apple insects. These non-apple compounds can be used alone or in blend combinations with apple compounds to produce a new, characteristic odour signal. Such signals' are different from the background of natural apple odour and may therefore be more suitable for use in insect monitoring and control.

15 Compound names:

2-Phenyl ethanol

Anethole

P-Anisaldehyde

(E,E)-alpha-Farnesene

20 (E)-beta-Farnesene

Farnesol

Linalool

Methylsalicylate

25 **Background of the invention**

Importance of new control methods for apple fruit moth *Argyresthia conjugella*.

Apple fruit moth *Argyresthia conjugella* Zeller (Lepidoptera, Argyresthiidae), is probably the most important pest of apple in Scandinavia (Ahlberg 1927, Fjeldalen 1974). The primary host of *A. conjugella* is rowan (mountain ash), *Sorbus aucuparia*. However,
30 flowering and fruitsetting of rowan is fluctuating strongly. Populations of *A. conjugella* build up in forests during good fruiting years, until every third to fourth year, when too few rowan berries are available for egg-laying (Ahlberg 1927, Sperens 1997 a,b).

Females of *A. conjugella* then invade apple orchards, where the entire crop can be destroyed.

35

Contamination of fruit and groundwater argues against the use of insecticides. Several insecticides used against apple fruit moth, such as azinphos methyl (Gusathion, Guthion), have been deregulated or will soon be deregulated in many countries (e.g. Koch &

Schietinger 1999). This demands the development of new pest control techniques.

Mating disruption by pheromone allows environmentally safe control of codling moth, another most important pest of apple (see below). One main argument against the use of
5 codling moth mating disruption in Scandinavia is that biological control methods are not available against apple fruit moth *A. conjugella*. Routine sprays are now used to simultaneously control *A. conjugella* and *C. pomonella*.

Availability of new, environmentally safe methods will bring ecological fruit growing into
10 reach, and will even reinforce the competitiveness of conventional fruit production in Scandinavia.

Importance of new control methods for codling moth *Cydia pomonella*

Codling moth *Cydia pomonella* L. (Lepidoptera, Tortricidae) is the key insect pest of
15 pome fruit worldwide. Several insecticides used against it will not be available to fruit farmers in the long run (see above). In addition, codling moth has grown resistant to most insecticides used against it (e.g. Boivin et al. 2001).

The most promising, environmentally safe approach to control codling moth is to use
20 non-toxic, behaviour-modifying chemicals (semiochemicals). Semiochemicals are divided into chemicals which mediate interactions between individuals of the same species (pheromones), and chemicals which mediate interactions between different species (kairomones and allomones).

25 Pheromone-mediated mating disruption disturbs the mate-finding behaviour of male moths. The mating disruption technique is already commercially used (Thomson et al. 2001). However, this technique is not operative at high population densities (Witzgall et al. 1999). The availability of a method to manipulate, in addition, the behaviour of egg-laying females would be most important.

30 Under mating disruption, monitoring traps baited with synthetic sex pheromone do not attract males: the background of synthetic pheromone abolishes male orientation to these traps. Females, in comparison with synthetic pheromone lures, release a blend containing several behaviourally active compounds. Males may accordingly still find females, while
35 pheromone trap catch is strongly reduced. It is therefore difficult to judge the efficacy of the mating disruption treatment according to captures in pheromone traps (Witzgall et al. 1999, 2001).

Other insects feeding on apple

When alleviating insecticide use, a number of other species, such as green budworm *Hedya nubiferana* or other leafroller moths, for example *Pandemis heparana*, need to be controlled. Females of these species lay eggs close to green apples, and they use volatile compounds to distinguish between their host plant and other non-host plants, or to distinguish between host trees with and without fruit.

Host-finding in insects is guided by plant volatiles

There is growing evidence that host-finding in moths is largely guided by secondary plant metabolites (Dethier 1982, Isman 1992, Metcalf & Metcalf 1992, Honda 1995, Schoonhoven et al. 1998). Gravid females make the critical host choice prior to and during oviposition, since newly hatched larvae cannot migrate over long distances. Higher plants release a large variety of volatile compounds, especially from reproductive organs. However, recent studies show that it is only a few "key" compounds which mediate long-range attraction, and that these compounds are perceived by specialized chemoreceptor neurons on the antenna (Anderson et al. 1995, Wibe et al. 1998, Rostelien et al. 2000). In a noctuid moth, *Helicoverpa armigera*, a synthetic six-component kairomone has been shown to elicit the same behavioral response as its host plant (Hartlieb & Rembold 1996).

Plant volatiles and host-finding in apple fruit moth

Volatile chemicals from rowan are undoubtedly critical for host-finding in *A. conjugella*. Apple fruit moth is a nocturnal species, attraction to rowan among mixed forest vegetation, and especially discrimination of fruiting and non-fruiting trees cannot be achieved by visual or gustatory cues.

The preferred host of *A. conjugella* is rowan. The survival rate of *A. conjugella* on apple is low, and an establishment of populations in orchards has not been reported (Ahlberg 1927). Attraction of *A. conjugella* to apple, during years when rowan berries are not available, is probably due to the co-occurrence of volatile constituents in rowan and apple. Apple and rowan belong to the the same plant family, Rosaceae, and related plants resemble each other even with respect to secondary metabolism (e.g. Berenbaum & Seigler 1992).

Therefore it has been hypothesized that traps baited with synthetic rowan volatiles should make an excellent tool to intercept migrating females at orchard borders. One particularly important advantage of such an artificial rowan lure is the absence of competing sources of natural rowan volatiles in orchards.

Plant volatiles and host-finding in codling moth and other species from apple

As outlined above ("Technical Field"), insects which primarily feed on apple *Malus domestica* (Rosaceae) may be sensitive to compounds which are typical even for other, closely plants of this family, such as rowan. The inverse is true for apple fruit moth,
5 which obviously is attracted to apple compounds.

Even for species occurring within apple orchards, use of rowan volatiles would be advantageous, as there are no competing' sources of natural rowan volatiles in orchards.

10

Use of plant volatiles in insect control

There are three main strategies to use plant volatile compounds for insect control: mass trapping, attract & kill and disruption of host-finding behaviour. These techniques are expected to result in efficient population control if a powerful
15 attractant for egg-laying females is available.

The female-produced sex pheromone of apple fruit moth (Jaastad et al. 2002) is not suitable for population control. Female sex pheromones, which effect only male behaviour, are used to control other orchard insects, such as codling moth or Oriental
20 fruit moth, either by mating disruption (Rice & Kirsch 1990, Gut & Brunner 1998) or male annihilation ("attracticide", "attract & kill") (Charmillot et al. 2000). These insects feed on apple, and a contiguous surface must be treated, including all adjacent orchards.

25 The main difference between apple fruit moth and other orchard insects is that apple fruit moth does not occur in the orchards prior to mating - mated females migrate from the forests into the orchards. Apple fruit moth eclose and mate in forests. In order to use sex pheromone for population control, one should accordingly treat all forests surrounding the orchards to be protected, which is difficult to achieve in most
30 locations, besides being very costly. Therefore, the sex pheromone of apple fruit moth can only be used in monitoring or warning traps, but not for population control.

In comparison, availability of a strong female attractant enables the use of either mass traps, an attracticide formulation (combination of attractant and insecticide),
35 or disruption of host-finding or egg-laying behaviour. In addition, availability of male and female attractants based on plant volatiles will also increase the reliability of traps used for population monitoring. This is true for all insect species, including all species living within apple orchards.

- WO 98/53678 relates to a device and a method for controlling pest insects by applying odour masking compounds, in particular phenolic compounds, in particular naphthalenic compounds, mono-terpenoidal compounds, aliphatic alkenes, and alkynes, as well as ketones and methyl ketones of aliphatic compounds. Among such odour masking compounds methylsalicylate, linalool, and allo-ocimene are mentioned. The substances are thus disclosed as odour masking compounds and not as attracting compounds.
- US-A-6,264,939 relates to novel bi-sexual attractants for codling moth, which attractants are derivatives of decadienoates. In the description it is shown that mature Bartlett pears contain 77 different volatile compounds, whereby t-anethole is present in 0.06 %, and (E,E)-alpha-farnesene is present with 20,53 % of a 100 % mixture of such volatile compounds while immature pears of the same specie contains 10,6 % of (E,E)-alpha-farnesene, and 0,21 % of 2-phenylethanol. Further, it is shown that immature apples contains linalool 6,58 % (Golden Delicious) respectively 3,94 % (Granny Smith), (E,E)-alpha-farnesene 22,5 % (Golden Delicious) respectively 12,4 % (Granny Smith), methylsalicylate 1,73 % (Golden Delicious) respectively 2,34 % (Granny Smith), and 2-phenylethanol 0,42 % (Golden Delicious) respectively 0,68 % (Granny Smith). The paper further shows that only 7 compounds are present both in immature and mature fruit, whereby, however, none of these belongs to the group of esters, viz. alkyl decanoates, decenoates, dodecanoates identified as attractants, aggregants or arrestants for Lepidoptera. Thus there is nothing in the prior art tending that compounds within the scope of the present invention, and defined below, can have a concisive attracting, aggregating or arresting effect.

J. Agric. Food Chem. 49, 3736-3741, (2001), Bengtsson, M. et al, Plant odour analysis of apple, in particular antennal response of codling moth females to apple volatiles during phenological development, whereby nine compounds are detected as being evaporated from branches and leaves while few of these compounds were obtained from green fruit.

STN INTERNATIONAL, file CAPLUS, AN 1998:588604, DN 129:273357, J. Chem. Etiol. 24(9)1491-1497 (1998) shows attraction of *Hoplia communis* to 2-phenylethanol, evaporated from *Rosa* spp.

Entomol. Exp. Appl. 102, 145-151 (2002) Hern, A., et al, Induction of volatile emissions from ripening apple fruits infested with *Cydia pomonella* and the attraction of adult

females, describes emission of volatile compounds by influence of larvae of *C. pomonella*.

5 US-A-6,440,406 relates to a composition to attract scarabee bugs, which composition contains phenylacetaldehyde, 2-phenylethanol, limonene, methyl-2-methoxybenzoate, and/or methylsalicylate.

10 STN INTERNATIONAL, file CAPLUS, AN 1998:588604, DN 129:273357, JP 07242505 A2 describes attractants for *Anomala octiescostata*, which attractants comprises anethole, geraniol, phenethyl propionate, benzaldehyde, phenylacetaldehyde, whereby the later two are present in an extract of dandelions.

Description of the present invention

15 Comparative chemical analysis of the volatile compounds released from rowan *Sorbus aucuparia* (Rosaceae) and apple *Malus domestica* (Rosaceae) by gas chromatography and mass spectrometry showed the co-occurrence of many volatiles in rowan and apple. Several compounds were released in large amounts from rowan, but only in trace amounts in apple.

20 In particular the invention relates to a formulation to be used in the control or monitoring of insects of the group *Argyresthia conjugella*, *Cydia pomonella*, *Hedya nubiferana* och *Pandemis heparana*, whereby the formulation contains one or more volatile plant compounds found in wild rowan *Sorbus aucuparia* or apple *Malus domestica* selected from the group consisting of 2-phenyl ethanol, anethole, p-anisaldehyde, benzyl alcohol, 25 beta-bourbonene, copaene, beta-cubebene, (E)-beta-farnesene, farnesol, cis-jasmone, limonene, cis-beta-ocimene, beta-phellandrene, phenylacetaldehyde, (Z)3-hexenyl 2-methylbutanoate, linalool, methyl salicylate, beta-caryophyllene, 4,8-dimethyl-1,3,(E)7-nonatriene, (E,E)-alfa-farnesene, germacrene D, and trans-beta-ocimene.

30 A preferred embodiment of the invention consists in a formulation wherein one or more of the volatile plant compounds is selected from the group consisting of anethole, p-anisaldehyde, benzyl alcohol, beta-bourbonene, copaene, beta-cubebene, (E)-beta-farnesene, farnesol, cis-jasmone, limonene, cis-beta-ocimene, beta-phellandrene, phenylacetaldehyde and 2-phenylethanol.

35

Another preferred embodiment of the invention consists in a formulation wherein one or more of the volatile plant compounds is selected from the group consisting of beta-

caryophyllene, 4,8-dimethyl-1,3(E)7-nonatriene, (E,E)-alfa-farnesene, germacrene D, linalool, trans-beta-ocimene, and methylsalicylate.

Another preferred embodiment of the invention consists in a formulation wherein one or
5 more of the volatile plant compounds is selected from the group consisting of decanal, (Z)3-hexenyl butanoate, (Z)3-hexenyl-2-methylbutanoate, nonanal.

A further preferred embodiment of the invention consists in a formulation wherein one
or more of the volatile plant compounds is selected from the group consisting of 2-
10 phenylethanol, anethole, p-anisaldehyde, (E,E)-alfa-farnesene, (E)-beta-farnesene, farnesol, linalool and methylsalicylate.

Another preferred embodiment of the invention relates to a formulation wherein 2-phenylethanol is included in the formulation.
15

Another preferred embodiment of the invention relates to a formulation wherein anethole is included in the formulation.

20 A further preferred embodiment of the invention relates to a formulation wherein 2-phenylethanol and anethole are included in the formulation, preferably in a weight ratio of 0.8-1.2:1, more preferably 1:1.

Another preferred embodiment of the invention relates to a formulation wherein
25 methylsalicylate and (E,E)-alfa-farnesene are included in the formulation.

Another preferred embodiment of the invention relates to a formulation wherein farnesol and (E)-beta-farnesene are included in the formulation.

30 A further preferred embodiment of the invention relates to a formulation wherein p-anisaldehyde and (Z)3-hexenyl-2-methylbutanoate are included in the formulation.
är inkluderade i formuleringen.

Another preferred embodiment of the invention relates to a formulation wherein
35 anethole and (Z)3-hexenyl-2-methylbutanoate are included in the formulation.

Another preferred embodiment of the invention relates to a formulation wherein (E)-beta-farnesene and (Z)3-hexenyl-2-methylbutanoate are included in the formulation.

A further preferred embodiment of the invention relates to a formulation wherein cis-jasmone and (Z)3-hexenyl-2-methylbutanoate är inkluderade i formuleringen.

- 5 Another preferred embodiment of the invention relates to a formulation wherein farnesole and (Z)3-hexenyl-2-methylbutanoate are included in the formulation.

A further aspect of the invention relates to a method for controlling or monitoring insect infestations of fruit orchards by the insects of the group *Argyresthia conjugella*, *Cydia pomonella*, *Hedya nubiferana* och *Pandemis heparana*, using volatile plant compounds from rowan *Sorbus aucuparia* and/or apple *Malus domestica* serving as an attractant, aggregating agent, arrestant or ovulation stimulation agent, whereby an attracting amount of a composition containing an attractant selected from the group consisting of 2-phenylethanol, anethole, p-anisaldehyde, benzyl alcohol, beta-bourbonene, copaene, beta-cubebene, (E)-beta-farnesene, farnesol, cis-jasmone, limonene, cis-beta-ocimene, beta-fellandrene, phenylacetaldehyde, (Z)3-hexenyl 2-methylbutanoate, linalool, methylsalicylate, beta-caryophyllene, 4,8-dimethyl-1,3-(E)7-nonatriene, (E,E)-alfa-farnesene, germacrene D, and trans-beta-ocimene is applied at fruit trees or is placed in a trap in connection to or on fruit trees where the adult insect or larvae infestation is to be monitored or control of the infestation is to be achieved.

A preferred embodiment of the method of the invention relates to the use of a formulation for controlling or monitoring a fruit tree infestation by apple fruit moth *Argyresthia conjugella*.

25 A preferred embodiment of the method of the invention relates to the use of a formulation for controlling or monitoring a fruit tree infestation by codling moth *Cydia pomonella*.

- 30 A further preferred embodiment of the method comprises use of a formulation which further encompasses an insecticide or a sexual pheromone.

The most important compounds predominantly found in wild rowan and several rowan clones were: anethole, p-anisaldehyde, benzyl alcohol, beta-bourbonene, copaene, beta-cubebene, (E)-beta-farnesene, farnesol, cis-jasmone, limonene, cis-beta-ocimene, beta-fellandrene, phenylacetaldehyde and 2-phenyl ethanol.

Compounds found in significant amounts, but different proportions, in both species were:

beta-caryophyllene, 4,8-dimethyl-1,3,(E)7-nonatriene, (E,E)-alfa-farnesene, germacrene D, linalool, trans-beta-ocimene and methyl salicylate.

5 Compounds found in apple only were: decanal, (Z)3-hexenyl butanoate, (Z)3-hexenyl 2-methylbutanoate, nonanal.

The compounds eliciting a strong response from antennae of female apple fruit moth and codling moth were then all tested in field traps for attraction of insects. Compounds were applied at a standard dose of 10 mg on red rubber septa, the septa were mounted in Tetra
10 traps with sticky bottoms (Arn et al. 1979).

Attraction of apple fruit moth

Several single compounds were found to attract apple fruit moth females and males in numbers significantly different from blank: anethole, p-anisaldehyde, linalool, methyl
15 salicylate and 2-phenyl ethanol. The single most attractive compound was 2-phenyl ethanol (Figure), followed by anethole and methyl salicylate.

Subsequently, several two-component blends were tested, and the blends showing a synergistic effect (stronger than an additive effect when combining compounds) were 2-phenyl ethanol plus anethole (Figure), and methylsalicylate plus (E,E)-alfa-farnesene.
20

Furthermore, 2-phenyl ethanol was tested in a series of 2-component blends, including all compounds which had shown some attractiveness by themselves. A blend of 2phenyl ethanol plus anethole was the most attractive for apple fruit moth males and females, and was more attractive than 2-phenyl ethanol alone (Figure), or
25 any other compound or compound blend tested. Anethole by itself was only a weak attractant and attracted less insects than 2-phenyl ethanol.

2-phenyl ethanol is an attractant for both males and females of apple fruit moth *Argyresthia conjugella*. Its attractivity can be augmented by blending it with
30 anethole. This blend was even rather species-specific, other insects were not attracted in significant numbers. Both sexes of *Argyresthia conjugella* were attracted. Attraction of females is of importance for monitoring the migration of mated females into orchards. Attraction of females enables population control by mass-trapping, by an attracticide formulation, or by disruption of mating and oviposition behaviour.

35 The activity of this blend can likely be augmented by adding further compounds identified from rowan or apple, such as methylsalicylate plus (E,E)-alfa-farnesene. The combination of compounds found in rowan and apple creates a new, characteristic odour

signal, which is different the background odour in apple orchards.

Attraction of codling moth

Codling moth males were attracted in significant numbers to traps baited with 10 mg of the rowan volatiles p-anisaldehyde, anethole, (E)-beta-farnesene, cis-jasmone and
5 farnesol, and to the apple volatile (Z)3-hexenyl 2-methylbutanoate. In a wind tunnel experiment, a blend of farnesol and (E)-beta-farnesene released at 10 ng/min attracted within 2 min 35% of the males tested to the source (N=60).

Attraction of insects from apple

10 The green budworm moth *Hedya nubiferana* and *Pandemis heparana* were attracted to blends containing (E)-beta-farnesene plus (E,E)-alfa-farnesene, and (E)-beta-farnesene plus cis-jasmone.

Application of the present invention

15 The described compounds or compound blends can be used in any kind of insect trap or system for confusing or disrupting behaviours, controlling, collecting, attracting, killing or monitoring insects. The compounds or blends can be included in other formulations to combine with effects of other compounds. Other insects than *Argyresthia conjugella*,
Cydia pomonella, *Hedya nubiferana* and *Pandemis heparana* could be attracted, confused
20 or even repelled by the described compounds or blend, giving the invention complete utility.

Related disclosures

25 Both compounds, 2-phenyl ethanol and anethole are widely distributed in the plant and animal kingdom. 2-Phenyl ethanol is an essential aroma and flavour component in fruit, tea, wine, cheese, bread and beer, and is also produced by several insects. Anethole is a common aroma component, which has also antifungal and insecticidal activity.

30 The most important publications on the occurrence and biological activity of 2-phenyl ethanol and anethole in insects are listed in Appendix I.

Attraction of *Argyresthia conjugella* to 2-phenyl ethanol has not been reported, and the blend of 2-phenyl ethanol and anethole has not been described to be attractive for any
35 other species. During our field trapping experiment, no other insects were attracted in significant numbers to 2-phenyl ethanol or the blend of 2-phenyl ethanol and anethole (1:1 w/w), 2-phenyl ethanol is species-specific under the conditions tested (region, time of season).

Attraction of codling moth to the compounds mentioned above has not been reported.

Appendix I**2-Fenyletanol**

2-Phenylethanol (in combination with n-valeric acid) attracts onion and seed-corn flie
Ishikawa Y, Matsumoto Y, Tsutsumi M, Mitsui Y (1984) Experimental field trapping of

5 the onion and seed-corn flies, *Hylemya antiqua* and *H. platura* (Diptera:
Anthomyiidae), using 2-phenylethanol for population estimation. Appl Entomol
Zool 19, 75-81.

Ishikawa Y, Matsumoto Y, Tsutsumi M, Mitsui Y (1984) Mixture of 2-phenylethanol
and n-valeric acid, a new attractant for the onion and seed-corn flies, *Hylemya*
10 *antiqua* and *H. platura* (Diptera: Anthomyiidae). Appl Entomol Zool 19, 448-455.

2-phenylethanol is a male-produced sex or aggregation pheromone in pheromone in
nitidulid beetles and noctuid moths

15 Jacobson M, Adler VE, Kishaba AM, Priesner E (1976) 2-Phenylethanol, a
presumed sexual stimulant produced by the male cabbage looper moth,
Trichoplusia ni. Experientia 32, 964-966.

Bartelt RJ, Carlson DG, Vetter RS, Baker TC (1993) Male-produced aggregation
pheromone of *Carpophilus mutilatus* (Coleoptera: Nitidulidae). J Chem Ecol 19,
20 107-118.

Birch MC, Poppy GM (1990) Scents and reversible scent structures of male moths.
Ann Rev Entomol 35, 25-28

2-Phenyl ethanol attracts ladybird beetles, lacewings, nitidulid beetles, noctuid moths,
25 scarabid beetles, stored-product beetles

Imai T, Maekawa M, Tsuchiya S, Fujimori T (1998) Field attraction of *Hoplia*
communis to 2-phenylethanol, a major volatile component from host flowers, *Rosa*
spp. J Chem Ecol 24, 1491-1497.

Haynes KF, Zhao JZ, Latif A (1991) Identification of floral compounds from *Abelia*
30 *grandiflora* that stimulate upwind flight in cabbage looper moths. J Chem Ecol 17,
637-646.

Honda K, Omura H, Hayashi N (1998) Identification of floral volatiles from *Ligustrum*
japonicum that stimulate flower-visiting by cabbage butterfly, *Pieris rapae*. J Chem
Ecol 24, 2167-2180.

35 Pierce AM, Pierce HD, Borden JH, Oehlschlager AC (1991) Fungal volatiles:
semiochemicals for stored-product beetles (Coleoptera: Cucujidae). J Chem Ecol
17, 581-597.

Zhu JW, Cosse AA, Obrycki JJ, Boo KS, Baker TC (1999) Olfactory reactions of the
twelve-spotted lady beetle, *Coleomegilla maculata* and the green lacewing,

- Chrysoperla carnea* to semiochemicals released from their prey and host plant: electroantennogram and behavioral responses. J Chem Ecol 25, 1163-1177.
- Zilkowski BW, Bartelt RJ, Blumberg D, James DG, Weaver DK (1999) Identification of host-related volatiles attractive to pineapple beetle *Carpophilus humeralis*. J Chem Ecol 25, 229-252
- 2-Phenylethanol attracts and repels house flies
- Adler VE, Jacobson M (1982) Evaluation of selected natural and synthetic products as house fly repellents. J Environm Sci Health 17A 5, 667-673.
- Chapman JW, Knapp JJ, Howse PE, Goulson D (1998) An evaluation of (Z)-9-tricosene and food odours for attracting house flies, *Musca domestica*, to baited targets in deep-pit poultry units. Entomol Exp Appl 89, 183-192.
- 2-Phenyl ethanol is produced by various ants, bark beetles, bugs, butterflies, caddisflies and moths, whereby the behavioural effect is still unclear
- Aldrich JR, Carroll SP, Oliver JE, Lusby WR, Rudmann AA, Waters RM (1990) Exocrine secretions of scentless plant bugs: *Jadera*, *Boisea* and *Niesthrea* species (Hemiptera: Heteroptera: Rhopalidae). Biochem Systemat Ecol 18, 369-376.
- Ansteeg O, Dettner K (1991) Chemistry and possible biological significance of secretions from a gland discharging at the 5th abdominal sternit of adult caddisflies (Trichoptera). Entomol Gen 15, 303-312.
- Birgersson G, Schlyter F, Lofqvist J, Bergstrom G (1984) Quantitative variation of pheromone components in the spruce bark beetle *Ips typographus* from different attack phases. J Chem Ecol 10, 1029-1055.
- Cruz LL, Morgan ED, Ondarza RN, Lopez LC (1995) Brindley's gland exocrine products of *Triatoma infestans*. Med Vet Entomol 9, 403-406.
- Gough AJE, Games DE, Staddon BW, Olagbemiro TO (1985) Male produced volatiles from coreid bug *Leptoglossus australis* (Heteroptera). Z f Naturforsch 40 c: 142-144.
- Ivarsson P, Birgersson G (1995) Regulation and biosynthesis of pheromone components in the double spined bark beetle *Ips duplicatus* (Coleoptera: Scolytidae). J Ins Physiol 41, 843-849
- Jacquin E, Nagnan P, Frerot B (1991) Identification of hairpencil secretion from male *Mamestra brassicae* (L.) (Lepidoptera: Noctuidae) and electroantennogram studies. J Chem Ecol 17, 239-246
- James DG, Moore CJ, Aldrich JR (1994) Identification, synthesis, and bioactivity of a male-produced aggregation pheromone in assassin bug, *Pristhesancus plagipennis* (Hemiptera: Reduviidae). J Chem Ecol 20, 3281-3295

- Lloyd HA, Blum MS, Duffield RM (1975) Chemistry of the male mandibular gland secretion of the ant, *Camponotus clarithorax*. Insect Biochem 5, 489-494.
- Omura H, Honda K, Hayashi N (2001) Identification of odoriferous compounds from adults of a swallowtail butterfly, *Papilio machaon* (Lepidoptera: Papilionidae). Z f Naturforsch 56 c, 1126-1134.
- Pureswaran DS, Gries R, Borden JH, Pierce HD (2000) Dynamics of pheromone production and communication in the mountain pine beetle, *Dendroctonus ponderosae* Hopkins, and the pine engraver, *Ips pini* (Say) (Coleoptera: Scolytidae). Chemoecol 10, 153-168.
- Renwick JAA, Pitman GB, Vite JP (1976) 2-Phenylethanol isolated from bark beetles. Naturwissenschaften 6, 198
- Wood WF, Palmer TM, Stanton ML (2002) A comparison of volatiles in mandibular glands from three *Crematogaster* ant symbionts of the whistling thorn acacia. Biochem Systemat Ecol 30, 217-222.
- Zhang QH, Birgersson G, Schlyter F, Chen GF (2000) Pheromone components in the larch bark beetle, *Ips cembrae*, from China: Quantitative variation among attack phases and individuals. J Chem Ecol 26, 841-858.
- 2-phenyl ethanol is a yeast metabolite attractive to bark beetles; *Ips pini* produces 2-phenyl ethanol when boring into fresh pine
- Brand JM, Schultz J, Barras SJ, Edson LJ, Payne TL, Hedden RL (1977) Bark-beetle pheromones: enhancement of *Dendroctonus frontalis* (Coleoptera: Scolytidae) aggregation pheromone by yeast metabolites in laboratory bioassays. J Chem Ecol 3, 657-666.
- Gries G, Smirle MJ, Leufven A,___ Miller DR, Borden JH, Whitney HS (1990) Conversion of phenylalanine to toluene and 2-phenylethanol by the pine engraver *Ips pini* (Say) (Coleoptera, Scolytidae). Experientia 46, 329-331.

Anetol

- Anethole attracts scarab beetles, hymenopterans, lovebugs
- Allsopp PG (1992) Volatile compounds as attractants for *Campsomeris tasmaniensis* (Saussure) (Hymenoptera: Scoliidæ). Austral Entomol Mag 19, 107-110.
- Cherry R (1998) Attraction of the lovebug, *Plecia nearctica* (Diptera: Bibionidae) to anethole. Florida-Entomol 81, 559-562.
- Cherry RH, Klein MG, Leal WW (1996) Attraction of adult *Anomala marginata* (Coleoptera: Scarabaeidae) to anethole. J Agr Entomol 13, 359-364.
- Crocker RL, Klein MG, Wei X, Nailon WT (1999) Attraction of *Phyllophaga congrua*, *Phyllophaga crassissima*, *Phyllophaga crinita*, and *Cyclocephala lurida* (Coleoptera:

Scarabaeidae) adults to selected volatile compounds. Southwestern Entomol 24, 315-320.

(E)-beta-farnesen

- 5 (E)-beta-farnesene attracts carabids, ladybirds, parasitoids, thrips
Al-Abassi S, Birkett MA, Pettersson J, Pickett JA, Wadhams LJ, Woodcock CM (2000)
Response of the seven-spot ladybird to an aphid alarm pheromone and an alarm
pheromone inhibitor is mediated by paired olfactory cells. J chem Ecol 26, 1765-
1771
- 10 Du Y, Poppy GM, Powell W, Pickett JA, Wadhams LJ, Woodcock CM (1998)
Identification of semiochemicals released during aphid feeding that attract
parasitoid *Aphidius ervi*. J chem Ecol 24, 1355-1368
Kielty JP, Allen WLJ, Underwood N, Eastwood EA (1996) Behavioral responses of
three species of ground beetle (Coleoptera: Carabidae) to olfactory cues
15 associated with prey and habitat. J Ins Beh 9, 237-250
Koschier EH, de-Kogel WJ, Visser JH (2000) Assessing the attractiveness of volatile
plant compounds to western flower thrips *Frankliniella occidentalis*. J chem Ecol
26, 2643-2655
Manjunatha M, Pickett JA, Wadhams LJ, Nazzi F (1998) Response of western flower
20 thrips, *Frankliniella occidentalis* and its predator *Amblyseius cucumeris* to
chrysanthemum volatiles in olfactometer and greenhouse trials. Ins Sci Appl 18,
139-144
- (E)-beta-farnesene is an oviposition stimulant in seed wasps
25 Kamm JA, Buttery RG (1986) Ovipositional behaviour of the alfalfa seed chalcid
(Hymenoptera: Eurytomidae) in response to volatile components of alfalfa.
Environm Entomol 15, 388-391.

Farnesol

- 30 Farnesyl pyrophosphate, the metabolically active form of farnesol, is a key
precursor in the synthesis of cholesterol, carotenoids, steroid hormones, bile acids
and other molecules involved in cellular growth and metabolism.
- Farnesol attracts fruit flies
35 Nigg HN, Mallory LL, Simpson SE, Callahan SB, Toth JP, Fraser S, Klim M, Nagy S,
Nation JL, Attaway JA (1994) Caribbean fruit fly, *Anastrepha suspensa* (Loew),
attraction to host fruit and host kairomones. J chem Ecol 20, 727-743

Farnesol is sex pheromone component in click beetles, aggregation pheromone component in bugs, hairpencil component in butterflies

James DG, Mori K, Aldrich JR, Oliver JE (1994) Flight-mediated attraction of *Biprorulus bibax* Breddin (Hemiptera: Pentatomidae) to natural and synthetic aggregation pheromone. *J chem Ecology* 20, 71-80

James DG, Heffer R, Amaike M (1996) Field attraction of *Biprorulus bibax* Breddin (Hemiptera: Pentatomidae) to synthetic aggregation pheromone and (E)-2-hexenal, a pentatomid defense chemical. *J chem Ecol* 22, 1697-1708.

Nishida R, Schulz S, Kim CS, Fukami H, Kuwahara Y, Honda K, Hayashi N (1996) Male sex pheromone of a giant danaïne butterfly, *Idea leuconoe*. *J chemi Ecol* 22, 949-972

Yatsynin VG, Rubanova EV, Okhrimenko NV (1996) Identification of female-produced sex pheromones and their geographical differences in pheromone gland extract composition from click beetles (Col., Elateridae). *J appl Entomol* 120, 463-466

Farnesol disrupts foraging in ants, deters oviposition in corn borer

Shorey HH, Gaston LK, Gerber RG, Phillips PA, Wood DL (1992) Disruption of foraging by Argentine ants, *Iridomyrmex humilis* (MAYR) (Hymenoptera: Formicidae), in citrus trees through the use of semiochemicals and related chemicals. *J chem Ecology* 18, 2131-2142

Binder BF, Robbins JC, Wilson RL (1995) Chemically mediated ovipositional behaviors of the European corn borer, *Ostrinia nubilalis* (Lepidoptera: Pyralidae). *J chem Ecol* 21, 1315-1327

References

- Ahlberg O (1927) Rönnebärsmalen, *Argyresthia conjugella* Zell. En redogörelse för undersökningar åren 1921-1926. Meddel. Nr. 324 från Centralanstalten för försöksväsendet på jordbruksområdet, Lantbruksentomologiska avdelningen, Stockholm.
- Anderson P, Hansson BS, Löfqvist J (1995) Plant-odour-specific receptor neurones on the antennae of female and male *Spodoptera littoralis*. *Physiol Entomol* 20, 189-198
- Arn, H., Rauscher, S., and Schmid, A. 1979. Sex attractant formulations and traps for the grape moth *Eupoecilia ambiguella* Hb. *Mitt. Schweiz. Entomol. Ges.* 52:49-55.
- Bengtsson M, Bäckman A-C, Liblikas I, Ramirez MI, Borg-Karlson A-K, Ansebo L, Anderson P, Löfqvist J, Witzgall P (2001) Plant odor analysis of apple: antennal response of codling moth females to apple volatiles during phenological development. *J Agr Food Chem* 49, 3736-3741
- Berenbaum M, Seigler D (1992) Biochemicals: engineering problems for natural selection, pp. 89-121 in Roitberg BD, Isman MB (eds.) *Insect chemical ecology*. Chapman & Hall, New York
- Boivin T, D'Hieres CC, Bouvier J-C, Beslay D, Sauphanor B (2001) Pleiotropy of insecticide resistance in the codling moth, *Cydia pomonella*. *Entomol exp appl* 99, 381-386.
- Charmillot P-J, Hofer D, Pasquier D (2000) Attract and kill: a new method for control of the codling moth *Cydia pomonella*. *Ent exp appl* 94, 211-216
- Dethier VG (1982) Mechanism of host plant recognition. *Entomol exp appl* 31, 49-56
- Fjeldalen J (1974) Organization of plant protection in Norway and research orientation. *Bull Org Eur Med Plant Prot* 4 (3), 241-249
- Gut, L. J.; Brunner, J. F. Pheromone-based management of the codling moth (Lepidoptera: Tortricidae) in Washington apple orchards. *J. Appl. Ent.* 1998, 15, 387-405.
- Hartlieb E, Rembold H (1996) Behavioral response of female *Helicoverpa (Heliothis) armigera* Hb. (Lep.: Noctuidae) moths to synthetic pigeonpea (*Cajanus cajan* L.) kairomone. *J Chem Ecol* 22, 821-837
- Honda K (1995) Chemical basis of differential oviposition by lepidopterous insects. *Arch Ins Biochem Physiol* 30, 1-23
- Isman MB (1992) A physiological perspective, pp. 156-176 in Roitberg BD, Isman MB (eds.) *Insect chemical ecology: an evolutionary approach*. Chapman & Hall, New York

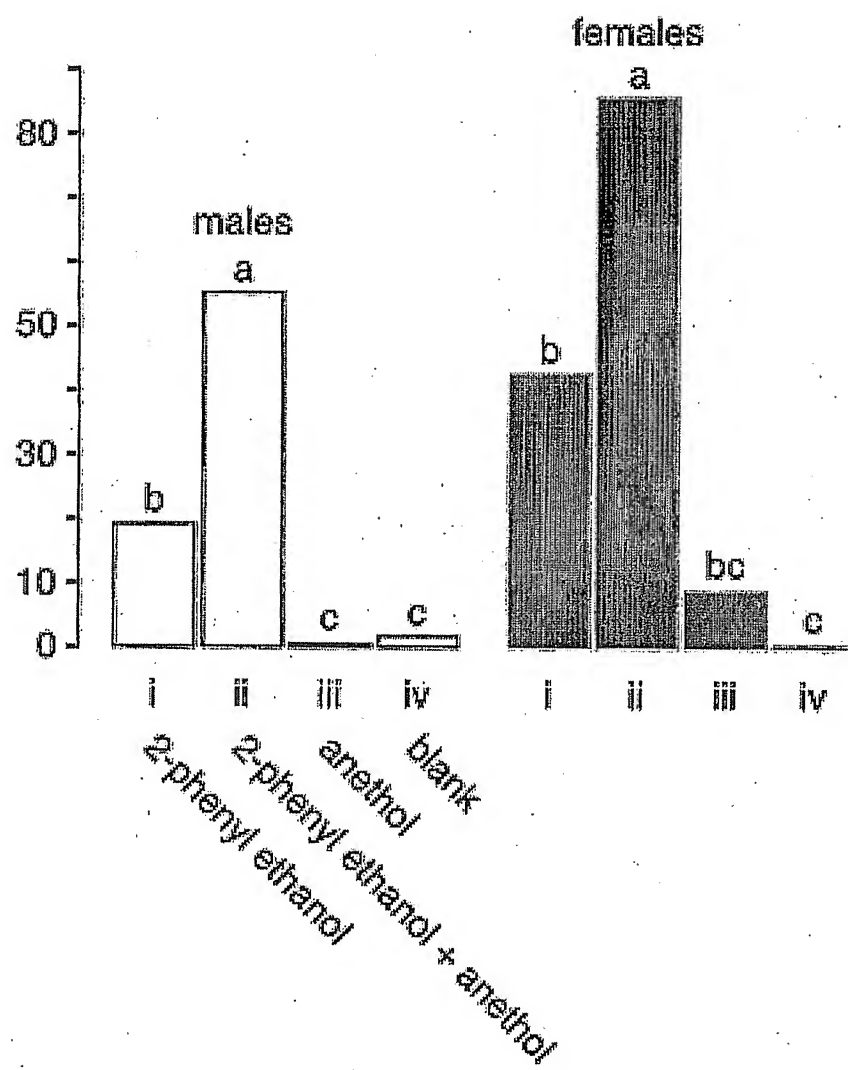
- Jaastad G, Anderson P, Bengtsson M, Kobro S, Knudsen G, Witzgall P (2002) Sex pheromone of apple fruit moth *Argyresthia conjugella* (Lepidoptera, Argyresthiidae). J Agric Forest Entomol 4, 1-4
- Koch HK, Schietinger R (1999) Abstandsauflagen und Zulassung von Pflanzenschutzmitteln im Obstbau. Obstbau 24(7), 362-365
- 5 Metcalf RL, Metcalf ER (1992) Plant kairomones in insect ecology and control. Chapman & Hall, New York
- Rice RE, Kirsch P (1990) Mating disruption of Oriental fruit moth in the United States, in: Behavior-modifying chemicals for insect management: applications of pheromones and other attractants, (Ridgway RL, Silverstein RM, Inscoe MN, eds.), pp. 193-211. Marcel Dekker, New York.
- 10 Røsteliën T, Borg-Karlson A-K, Fäldt J, Jacobsson U, Mustaparta H (2000) The plant sesquiterpene germacrene D specifically activates a major type of antennal receptor neuron of the tobacco budworm moth *Heliothes virescens*. Chem Senses 25, 141-148
- 15 Schoonhoven LM, Jermy T, van Loon JJA (1998) Insect-plant biology: from physiology to evolution. Chapman & Hall, London.
- Sperens U (1997a) Long-term variation in, and effects of fertiliser addition on, flower, fruit and seed production in the tree *Sorbus aucuparia* (Rosaceae). Ecography 20, 521-534
- 20 Sperens U (1997b) Fruit production in *Sorbus aucuparia* L. (Rosaceae) and pre-dispersal seed predation by the apple fruit moth (*Argyresthia conjugella* Zell.). Oecologia 110, 368-373
- Thomson D, Brunner J, Gut L, Judd G, Knight A (2001) Ten years implementing codling moth mating disruption in the orchards of Washington and British Columbia: starting right and managing for success! IOBC wprs Bulletin 24(2), 23-30
- 25 Wibe A, Borg-Karlson A-K, Persson M, Norin T, Mustaparta H (1998) Enantiomeric composition of monoterpene hydrocarbons in some conifers and receptor neuron discrimination of α -pinene and limonene enantiomers in the pine weevil, *Hylobius abietis*. J chem Ecol 24, 273-287
- 30 Witzgall P, Bäckman A-C, Svensson M, Koch UT, Rama F, El-Sayed A, Strandh M, Brauchli J, Arn H, Bengtsson M, Löfqvist J (1999) Behavioural observations of codling moth, *Cydia pomonella*, in orchards permeated with synthetic pheromone. BioControl 44, 211-237
- 35 Witzgall P, Bengtsson M, Rauscher S, Liblikas I, Bäckman A-C, Coracini M, Anderson P, Löfqvist J (2001) Identification of further sex pheromone synergists in the codling moth, *Cydia pomonella*. Ent exp appl 101, 131-141

CLAIMS

1. Formulation to be used for controlling or monitoring insects of the group *Argyresthia conjugella*, *Cydia pomonella*, *Hedya nubiferana* and *Pandemis heparana*,
characterized in that the formulation contains one or more volatile plant compounds of
5 rowan *Sorbus aucuparia* or apple *Malus domestica* selected from the group consisting of
2-phenylethanol, anethole, p-anisaldehyde, benzyl alcohol, beta-bourbonene, copaene,
beta-cubebene, (E)-beta-farnesene, farnesol, cis-jasmone, limonene, cis-beta-
ocimene, beta-fellandrene, phenylacetaldehyde, (Z)3-hexenyl 2-methylbutanoate,
linalool, methylsalicylate, beta-caryophyllene, 4,8-dimethyl-1,3-(E)7-nonatriene, (E,E)-
10 alfa-farnesene, germacrene D, and trans-beta-ocimene.
2. Formulation according to claim 1, wherein one or more of the volatile plant
compounds is selected from the group consisting of anethole, p-anisaldehyde, benzyl
alcohol, beta-bourbonene, copaene, beta-cubebene, (E)-beta-farnesene, farnesol, cis-
15 jasmone, limonene, cis-beta-ocimene, beta-fellandrene, phenylacetaldehyde and 2-
phenylethanol.
3. Formulation according to claim 1, wherein one or more of the volatile plant
compounds is selected from the group consisting of beta-caryophyllene, 4,8-dimethyl-
20 1,3(E)7-nonatriene, (E,E)-alfa-farnesene, germacrene D, linalool, trans-beta-ocimene,
and methylsalicylate.
4. Formulation according to claim 1, wherein one or more of the volatile plant
compounds is selected from the group consisting of decanal, (Z)3-hexenyl butanoate,
25 (Z)3-hexenyl-2-methylbutanoate, nonanal.
5. Formulation according to claim 1, wherein one or more of the volatile plant
compounds is selected from the group consisting of 2-phenylethanol, anethole, p-
anisaldehyde, (E,E)-alfa-farnesene, (E)-beta-farnesene, farnesol, linalool and
30 methylsalicylate.
6. Formulation according to claim 1, wherein 2-phenylethanol is included in formulation.
7. Formulation according to claim 1, wherein anethole is included in formulation.
35
8. Formulation according to claim 1, wherein 2-phenylethanol and anethole are included
in formulation.

9. Formulation according to claim 8, wherein 2-phenylethanol and anethole are present in a weight ratio of 0.8-1.2, preferably 1:1
10. Formulation according to claim 1, wherein methylsalicylate and (E,E)-alpha-farnesene are included in formulation.
11. Formulation according to claim 1, wherein farnesol and (E)-beta-farnesene are included in formulation.
12. Formulation according to claim 1, wherein p-anisaldehyde and (Z)3-hexenyl-2-methylbutanoate are included in formulation.
13. Formulation according to claim 1, wherein anethole and (Z)3-hexenyl-2-methylbutanoate are included in formulation.
14. Formulation according to claim 1, wherein (E)-beta-farnesene and (Z)3-hexenyl-2-methylbutanoate are included in formulation.
15. Formulation according to claim 1, wherein cis-jasmone and (Z)3-hexenyl-2-methylbutanoate are included in formulation.
16. Formulation according to claim 1, wherein farnesol and (Z)3-hexenyl-2-methylbutanoate are included in formulation.
17. Method for controlling or monitoring insect infestations of fruit orchards by the insects of the group *Argyresthia conjugella*, *Cydia pomonella*, *Hedya nubiferana* och *Pandemis heparana*, using volatile plant compounds from rowan *Sorbus aucuparia* and/or apple *Malus domestica* serving as an attractant, aggregating agent, arrestant or ovulation stimulation agent, whereby an attracting amount of a composition containing an attractant selected from the group consisting of 2-phenylethanol, anethole, p-anisaldehyde, benzyl alcohol, beta-bourbonene, copaene, beta-cubehene, (E)-beta-farnesene, farnesol, cis-jasmone, limonene, cis-beta-ocimene, beta-fellandrene, phenylacetaldehyde, (Z)3-hexenyl 2-methylbutanoate, linalool, methylsalicylate, beta-caryophyllene, 4,8-dimethyl-1,3-(E)7-nonatriene, (E,E)-alpha-farnesene, germacrene D, and trans-beta-ocimene is applied at fruit trees or is placed in a trap in connection to or on fruit trees where the adult insect or larvae infestation is to be monitored or control of the infestation is to be achieved.

18. Method according to claim 17, for controlling or monitoring fruit orchard infestation by apple fruit moth *Argyresthia conjugella*.
19. Method according to claim 17, for controlling or monitoring fruit orchard infestation
5 by codling moth *Cydia pomonella*.
20. Method according claim 19, wherein the formulation further comprises an insecticide or a sexual pheromone.



FIGURE